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INTEGRATED RIVER BASIN DEVELOPMENT AND INDUSTRIALIZATION : THE TENNESSEE VALLEY EXPERIENCE

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INTEGRATED RIVER BASIN DEVELOPMENT AND INDUSTRIALIZATION: THE TENNESSEE VALLEY EXPERIENCE

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1. The integrated river basin development experiment of the Tennessee Valley Authority (TVA), now in its 30th year, can provide valuable guidance for the industrialization efforts of the less developed areas.
2. During the next 40 or 50 years, several hundred billion dollars will be invested in integrated river basin projects throughout the world, according to a recent estimate by a panel of United Nations' experts.[1] At present, more than thirty-four countries are using portions of the TVA experience in valley development schemes such as the Damodar in India, the San Francisco in Brazil, and the Volta River in Ghana.[2] And in virtually all of these projects, industrialization is expected to be one of the major results.

River Basin Development and Industrialization: General Theory

3. What is the causal relationship between integrated river basin projects and industrialization? One basic characteristic of such programs is that they are only a partial approach to the development of a region. A comprehensive development effort to raise levels of production, employment and income in an area would include many governmental and non-governmental programs which are normally outside the scope of an integrated river basin project. The TVA, for example, is erroneously considered to have broad authority in its area. But it has no direct control over many activities necessarily involved in a full development program such as taxes, fiscal policies, transportation rates and policies, agricultural policy, tariffs and foreign trade, public investment in roads, schools, hospitals and educational policies. The only legal powers granted to the TVA are the right of eminent domain, the right to spend available funds and, recently, the right to raise investment funds through the sale of bonds.
4. In TVA's region, other Federal agencies continue to operate programs and exercise their authority in all customary fields on the basis of national policies, which may or may not be consistent with the objectives of the regional project. State and local governments in the Valley region also continue to exercise virtually all of their customary powers. The TVA Act (Sections 22 and 23) does provide, however, for an indirect advisory approach through studies and surveys for harmonizing the Valley's programs with other governmental activities. TVA's limited authority can be explained by special historical, political and other features of the American scene. And river basin projects in other countries are generally endowed with a different degree and mix of legal authority. But because river basin projects do not conform to the boundaries of already existing political units, the normal pattern throughout the world is to vest only limited authority in river basin agencies.
5. A second basic characteristic of river basin projects is that their main influence is on the physical supply and cost conditions of certain resources in the region. The rate at which the improved resource situation is translated into new and expanded industrial activity will depend upon demand factors usually outside the control of the

river basin project. A successful program can improve the physical availability of hydro-electric power, forest products, industrial water, agricultural materials and water transportation and thereby increase the potential for industrialization. But improved physical availability is not a sufficient condition for industrial development. Markets must exist for the specific resources being improved. Business entrepreneurship, government or private, must be active. And complementary policies and activities by other government and private agencies are essential. Furthermore, depending upon the locational characteristics of new enterprises, the industrialization stimulated by the improved resource situation may be most efficiently located outside of the valley region.

6. It might be argued that the large investments required for a river basin project and their multiplier effects will create a self-generating regional demand for resources. In a predominantly agricultural region, however, a large share of the direct impact of investment expenditures is likely to be outside of the basin and even outside of the country. In the case of low income areas, however, the share remaining in the region may still be significant in relation to total regional income or investment. From inception in 1933 to 1962 the TVA involved a total of more than $2 billion in new investment, of which less than 50 per cent went for goods and services supplied by the region. Over the 29 year period, the expenditures made by TVA in the region averaged less than two per cent of total personal income in the area.

7. The geography of the investment expenditure impact will depend upon the specific composition of the project and the productive facilities of the region and the country. Expenditures for construction labor and many services will generally mean increased income and employment in the region. But the substantial expenditures for generators, turbines and other electrical, mechanical and construction equipment will normally go to the developed regions or the foreign countries which produce this equipment. The expenditures for steel, cement, and other construction materials will have little immediate influence on regional demand unless these products are produced in the region. The limited "demand effect" in the region of most river basin projects is important to keep in mind. It emphasizes the importance of expanding only the type of resources for which a future demand will exist.

An Overview of Valley Economic Trends

8. The Tennessee Valley Region, including the watershed and power service area covers 92,000 square miles and has a population of about 6,200,000. The rough terrain coupled with abundant rainfall, averaging 52 inches per year, insures an outstanding supply of waterpower. But rugged topography and relatively poor quality soils limit the region's agricultural capacity even though rainfall and climate are favorable. More than half of the land area is in forests. And the region's mineral resources are generally of low quality and found in small deposits.

9. Three decades ago, the Tennessee Valley presented a somewhat typical picture of an economically underdeveloped region. The area was heavily populated and both human and physical resources were greatly underutilized. In fact, the region's most valuable physical resource -- abundant water -- was causing economic damage through flooding and erosion rather than making a positive contribution to economic welfare. Low productivity agriculture was the predominant source of employment and income. Underemployment was widespread and a critical need existed for utilizing more fully both natural and human resources through industrialization. Average per capita income in the Valley, even in the prosperity year of 1929, was only 45 per cent of the national average, $317 as compared to $703 per person in the nation as a whole.

10. The Shift from Agriculture to Industry: Since 1933 when the TVA was established, the Valley economy has grown at a faster rate than the nation and has shifted from a predominantly agricultural area to an important and expanding industrial region. By 1960, due both to rapid industrialization and extensive outmigration of surplus labor, income per capita in the Tennessee Valley reached a level of $1,378 or 64 per cent of the national average.

11. Agricultural trends in the Tennessee Valley generally followed the national patterns of sharp declines in farm employment and only modest gains in total farm income.

From 1930 to 1960, despite a steadily growing total labor force, the number of workers in Valley agriculture declined by 70 percent. Yet, over the same period, total farm income doubled. Income per farm worker gained greatly, of course, but still remained significantly below levels in the rest of the country. Due to below-average agricultural potentials and a less favorable impact of national agricultural programs on Valley agriculture as compared to other farm areas, the Valley's farming sector contributed little if any to the narrowing of the economic gap between the region and the rest of the country.

12. Industry, on the other hand, expanded more rapidly in the Tennessee Valley than in the nation as a whole or in the larger Southeast region. Manufacturing employment increased from 222,000 in 1929 to 486,000 in 1960, a gain of 119 per cent as compared to 55 per cent in the nation and 101 per cent in the Southeast. Manufacturing wages and salaries grew from $213 million in 1929 to $1.9 billion in 1960, an increase of 807 per cent as compared to 443 per cent in the Nation and 720 per cent in the Southeast. (The Southeast region includes the 11 states of Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, Tennessee, South Carolina, and Virginia.)

13. The differential trends in agriculture and industry changed greatly the regional structure of economic activity. In 1930 about half of the Valley's employment was in agriculture as compared to 13 per cent in manufacturing. But by 1960, farm employment had dropped to 14 per cent of the total, while manufacturing jobs increased to 26 per cent. In other words, the ratio of farm to factory workers was four to one in 1930, but by 1960 farm workers were outnumbered by factory workers by a margin of almost two to one. As sources of regional income, the positions of agriculture and industry have also been reversed. In 1929 personal income from agriculture was almost twice as important as that from manufacturing. But by 1960 manufacturing was providing almost three times the income from agriculture. Industrial expansion, by providing an increasing number of relatively high income jobs for the region, greatly stimulated employment in the "tertiary" fields of trade, services, finance, etc. Trade and service employment expanded from about 560,000 in 1930 to about one million in 1960, an increase of 1.8 jobs in trade and services for each new manufacturing job.

14. The industrialization of the Tennessee Valley, an open economy within the larger Southeast region and the still larger national political unit, has been influenced, of course, by national policies and trends. For example, manufacturing employment in the United States expanded as much over the eight year period from 1939 to 1947 as over the prior 50 year period from 1889, and the Tennessee Valley shared in this expansion. Furthermore, the Southeast as a whole has in recent years attracted a large share of the nation's industrial expansion.[3]

15. Population and Migration Trends: The broad population, migration and employment patterns that accompanied rapid industrialization in the Tennessee Valley are extremely significant. Although the Valley's rate of natural increase in population (excess of births over deaths) has been consistently above that for the nation, population remaining in the Valley increased by only 24.5 per cent as compared to 45.6 per cent for the nation over the 30 year period, 1930 to 1960. Consequently, an estimated 1,500,000 people, including about 500,000 members of the labor force, migrated from the Valley region in the last three decades. This compares to a present population of 6.2 million. This phenomenal outmigration, also characteristic of the larger Southeast region, indicates that manufacturing and other non-farm employment did not expand enough to use the large amount of manpower available in the region -- the workers leaving agriculture and new entrants to the labor force. It also reflects the rapid growth of new job opportunities outside the region.

TVA Programs Affecting Industrialization

16. The special feature of integrated river basin projects is that a number of development activities complement each other in providing the basis for industrial expansion. For example, the Bowaters Southern newsprint mill, involving a $126 million investment, was located in the Tennessee Valley to make use of at least five different resources improved by TVA programs. The paper mill draws upon the improved valley forests for

raw materials, the new waterway to bring pulpwood to the mill, economical electric power and clean industrial water from a tributary river. Also, it is located on a site that would be flooded frequently without the protection of the TVA system of dams. Remove any of these five resources and the plant would, in all likelihood, have been located elsewhere. Furthermore, the plant expansion was greatly influenced by technical studies and technical assistance programs of TVA.

17. The key TVA programs influencing industrialization will be briefly described, but the inter-dependence of these activities must be kept in mind.

18. Physical resources development:

(a) Electric power: Power use in the Valley region increased from 1-1/2 to 63 billion kilowatt hours from 1933 to 1961. The installed capacity of the system on June 30, 1961 was about 12 million kw, and of the total power generated during the year three-fourths came from steam plants and one-fourth from hydroelectric installations. Government installation -- including two atomic energy plants, an air force engineering center, and missile and space activities -- used 44 per cent of total electric power consumption, private industry and commerce about 30 per cent, and residential users the remaining 26 per cent.

(b) Flood control: An integrated system of 31 dams controls the flow of the river system and provides nearly 15 million acre feet of storage for flood control. Thus, along the river a large and dependable supply of industrial water is available and hundreds of industrial sites have become usable.

(c) Navigation: A 650 mile navigable channel was completed in 1945 linking the Valley with the 9,000 mile inland waterway system connecting 20 states. River traffic increased from 33 million ton-miles in 1933 to 258 ton-miles in 1945, when the full channel was completed, to 2.3 billion in 1960. Coal and coke, grains, and petroleum products accounted for 86 per cent of the ton miles in 1960.

(d) Fertilizers: TVA's chemical plant at Muscle Shoals, Alabama is the nation's only large scale laboratory and experimental center for development of fertilizers. A fertilizer use and demonstration program promotes agricultural development in the Valley and across the nation. The research results on fertilizer materials and manufacturing processes have been made available on a royalty-free basis to 190 industrial firms throughout the United States.

(e) Forestry: TVA has promoted reforestration, fire protection, and sustained-yield management as support for an expanding forest products industry. The forest area in the Valley, largely privately owned, increased eight per cent in the past 26 years, and these forests contain 16 per cent more growing stock and five per cent more saw timber than ten years ago. Fire protection is now adequate on about 90 per cent of the land.

(f) Recreation: TVA has encouraged recreation use of the reservoirs through many activities which include making land available to public agencies for wildlife refuges, parks and access areas. One major industrialization effect has been the rapid growth of a boat manufacturing industry in the Valley.

19. Technical Studies and Research: Of special importance to industrialization have been TVA technical studies and research such as topographic mapping, forest inventories, minerals exploration and processing research, food processing research, and techno-economic industrial opportunity studies. TVA topographic mapping has now covered most of the river basin and the maps have become widely used for industrial development and local-regional planning. Three valley-wide forest inventories and 75 detailed county inventories have been an important stimulant for expansion of forest industries. Especially during its early years, TVA joined with the State governments to compile valuable data on mineral resources and to develop improved minerals processing methods. Food processing research, particularly on freezing techniques, gave early impetus to the establishment of canning and freezing plants in the Valley. A few techno-economic studies such as the feasibility of locating a paper and pulp mill in the Valley had great success in stimulating industrialization. In conformity with its philosophy of institution building to be discussed below, TVA's general pattern was to initiate research activities in cooperation with state and local agencies and to withdraw from the field after other agencies were prepared to assume responsibility.

20. Planning and industrial promotion: The TVA early rejected the concept of a

"planned" region in favor of the idea of a "planning" region. Consequently, neither a blueprint plan for industrialization nor for comprehensive development was ever prepared. The preferred alternative was to encourage the development of the planning function by scores of agencies and institutions in the region.[4] TVA's development success suggests that the TVA approach of a decentralized planning process rather than a master plan merits attention from the less developed areas. TVA's decision as to planning approach was influenced, of course, by almost complete reliance in the U. S. on private enterprise for industrial expansion and by TVA's limited authority for implementing an industrial plan. But even more significant was the philosophy of TVA management -- that planning and development are the democratic tasks of many institutions and countless individuals and that the maximum rate of development would be achieved by enlisting the full participation of people and institutions in the region. TVA's approach, therefore, meant a maximum commitment to so-called "institution building."

21. TVA adopted a policy of low but not subsidized electricity rates which were generally uniform throughout the region. The uniform rate policy was expected to encourage decentralization. Still another direct action was to reserve for industrial use a number of waterfront sites owned by TVA.

22. In the field of industrial promotion, an important activity in the United States and in other private enterprise economies, the TVA was severely restricted. As a Federal agency supplied with tax funds from the entire country, TVA was constantly vulnerable to political charges that it was using funds from other regions to "steal" their industries even though industrial relocation has been almost negligible in total Valley industrialization. Whatever aggressive industrial promotion activities the region chose to undertake had to develop, therefore, at the state and local government levels and through regional groupings of the TVA power distributors, all of which are municipally or cooperatively owned. And over the last decade in particular, a full range of industrial promotion techniques and agencies have emerged in the Tennessee Valley states. These non-TVA activities, ranged from special tax inducements and financial assistance to nation-wide personal solicitation of industrial firms to locate in the region.

23. Investment in TVA: The gross investment in TVA for water control and power facilities as of 1961 was $2,417 million, but the river basin projects accounted for only $836 million of the total. The remaining $1,581 million was for steam power plants, which in 1961 produced 75 per cent of total electric energy generated, and transmission lines. Total electric power, both hydro and steam plants, plus transmission facilities reached about $2,000 million or 84 per cent of the over-all TVA investment. The investment for hydro capacity on a historical cost basis averages between $120-$130 per kilowatt of installed capacity and for steam electric stations between $130-$140. The overall investment in power generation, transmission and distribution is about $200 per kilowatt of capacity. The navigation system averages about $290,000 per mile of the navigable channel.

The Over-all Pattern of Industrialization

24. A major difficulty underlying economic evaluations of river basin projects is that most governments collect their statistics by political rather than natural resource regions. Through special tabulations of census data, however, detailed industry information for the Tennessee Valley is available for the 1939 to 1958 period. This time interval covers about three-fourths of total employment gains for the region over the 1929 to 1960 period. As of 1958, the structure of the Valley's manufacturing sector differed greatly from the national pattern. The labor oriented and relatively low wage apparel and textile industries employed 31 per cent of Valley workers as compared to 13 per cent in the nation. But the chemical industry was more than twice as important in the region as the nation. This Valley industry, of course, includes atomic energy plants at Oak Ridge, Tennessee and Paducah, Kentucky. Food processing, saw mills and wood products based on the region's forest resources, primary metals and fabricated metals are next in importance for the Valley. On the other hand, the

manufacture of transportation equipment and electrical machinery rank much higher in the nation than in the Valley.

25. Growth Industries: More significant than the static picture is the dynamic growth pattern of industrialization. In terms of new jobs, the most important industries were apparel, food, chemicals, electrical machinery, furniture, primary metals, leather, non-electrical machinery, pulp and paper, and transportation equipment. These ten groups provided 80 per cent of the new jobs. In terms of rate of increase, the most dynamic industry was electrical machinery with a phenomenal gain over 1939. Other rapid growth industries in order of importance were transportation equipment, machinery, instruments and related products, rubber products, pulp and paper, furniture and apparel.

26. The industrialization pattern has differed for the various time periods. From 1939 to 1947, the World War II period, the basic materials industries of chemicals, primary metals and lumber were the leaders in expansion, accounting for almost 40 per cent of the total employment gain. In the post-war period, however, the consumer goods industries came to the fore. From 1947 to 1958, apparel and food industries accounted for 50 per cent of the employment increase in manufacturing. Electrical machinery which includes both producers and consumers goods provided another 15 per cent of the new jobs. "Value added" expanded rapidly in chemicals, primary metals and rubber products even though in the case of metals and rubber, employment showed little or no increase in recent years. This reflects continued productivity gains through heavy capital investment and automation.

27. The Spatial Pattern of Industrialization: The geographical distribution of the industrial expansion within the Valley is of special interest to proponents of rural industries and opponents of urbanization. Manufacturing activity in the Valley has continued to be heavily concentrated in urban counties. In 1959, 17 urban counties with 31 per cent of total population had 50 per cent of the region's factory workers. On the other hand, 106 rural counties with 27 per cent of the population had only 11 per cent of factory employment. Trends over the 1929-1950 period indicate considerable stability in the distribution of employment between rural, urban and metropolitan counties.[5]

Direct Industrialization Effects of TVA Programs

28. As emphasized previously, many development factors other than the TVA project contributed to the industrialization of the Valley region. Also, the development effects of the TVA project occurred in many sectors other than the field of manufacturing and in many other regions. It is precarious, therefore, to attempt to eatablish a cause and effect relationship between TVA programs and specific industrialization projects in the region. Nevertheless, as a rough estimate, the new Valley industries directly related to TVA programs accounted over the 1939-58 period for one-third of the new industrial jobs and at least one-half of the increased value added by industry. Total investment figures are not available, but because of the capital intensive nature of most of the TVA-oriented industrial expansion, it is clear that this group accounted for well over half of total new manufacturing investment in the Valley. Specific industry groups and manufactured products attracted by TVA programs are as follows:

(a) Chemicals: Industrial chemicals such as chlorine, caustic soda, sulphuric and hydrofluoric acid, oxygen, nitrogen, acetylene derivatives, sodium chlorate, hydrogen sulfite gas, titanium dioxide, titanium sponge, chemical coke; plastics; nylon and other man-made fibers; and fertilizers.

(b) Primary metals: Primary aluminum, electro manganese and ferroalloys, and copper tubing.

(c) Forest products: Pulp and paper, paperboard.

(d) Electrical machinery: Power, distribution and specialty transformers, motors and generators, instruments and electronic components.

(e) Food: Grain mills, poultry and dairy processing, animal feeds, frozen foods and meat packing.

29. The share of Valley industrialization indirectly stimulated by TVA's contribution to increased regional income is impossible to estimate quantitatively. Much

of this effect was in consumer goods industries such as apparel, furniture, shoes and electrical appliances -- categories in which considerable Valley expansion occurred but oriented primarily to national markets.

30. Several characteristics of the TVA inspired industrialization deserve special comment. The bulk of the industrialization attracted by electric power and improved water, minerals and forest resources is heavy industry producing for a national market. These resources oriented industries attracted some additional supplier industries, e.g. an alum plant was established in the valley to supply a paper mill, but few final product industries. In the case of the aluminum products industry, for example, the locational advantage is proximity to the markets rather than to primary aluminum producers. The chemicals, primary metals and paper industry plants attracted to the Valley are extremely capital intensive and employ relatively little labor in relation to the investment. Large paper mills involved an investment of $30,000 per worker; paperboard plants, $70,000 per worker; and the Calvert City chemical and electrometallurgical complex, $70,000 per worker. These figures compare with an over-all average of $8,000 per worker for all types of industrial development in the TVA area over the period from 1958 through 1961. In the early days of TVA, "rural industries" and handicraft activities were hopefully emphasized as an important source of employment for surplus workers in agriculture. However, a study of the expansion of rural industries in the Southeast over the period from 1939 to 1947 indicated that the number of jobs in rural industries expanded at a lesser rate than for all manufacturing, and that rural industries were not a promising solution to the employment problem.[6]

31. The extensive industrial complex which now exists at Calvert City, Kentucky is a dramatic and concentrated illustration of TVA supported industrialization. In the past 14 years Calvert City has grown from a small crossroads town of only 319 persons into a major industrial center with about 25 separate plants and processing units manufacturing chemicals, chemical products and ferroalloys. The plants employ about 2,000 workers and represent an investment of about $137 million. A combination of low cost electric power, river transportation and a large dependable water supply attracted the basic plants to this area. They, in turn, are attracting a number of satellite plants. TVA has a total of 270,000 kilowatts under contract to industry in this area which represents an investment in power facilities of about $50,000,000. Each industrial job, therefore, has required an over-all industrial plus power investment of almost $90,000.

Applications for the Less Developed Areas

32. The resource composition and the environment for integrated river basin projects in other areas is likely to differ greatly from the TVA situation. Nevertheless, the less developed areas can benefit by examining the different aspects of the TVA experience and by reformulating the results of TVA's thirty years of experience to fit their different circumstances. Fortunately, the TVA experience has been unusually well documented and analyzed from many standpoints.

33. Integrated river basin projects are massive investment ventures and are neither a cheap nor a quick way to create new industrial employment. But over a long period they can stimulate a significant amount of industrialization. The early planning of such projects must be integrated into national planning so that specific river basin programs will fit national development needs rather than the physical resource characteristics of the area. Furthermore, many complementary programs and projects beyond the normal scope of river basin projects are absolutely essential to secure rapid and significant industrialization results. Particularly important is the need to upgrade human and institutional resources to the point where they can make effective use of the direct results of the physical resource development programs.

34. Probably the greatest contribution of a river basin project to industrialization and economic development in general can be through regional institution building and through providing a new growth perspective to an area. An integrated river basin project as a dramatic regional venture can be an invaluable framework for mobilizing all the human and institutional resources of a region for new high levels of development. On the other hand, if such projects are not critically appraised and viewed in proper perspective they can siphon off the productive energies of an economy toward the end of "monument building."

1 Integrated River Basin Development, Report by a Panel of Experts, United Nations, p. 8, New York (1958).

2 TVA Technical Library, TVA--Symbol of Valley Resource Development, Tennessee Valley Authority, Knoxville, Tennessee (June 1961).

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1739 E - Nov.1962 - 1,600